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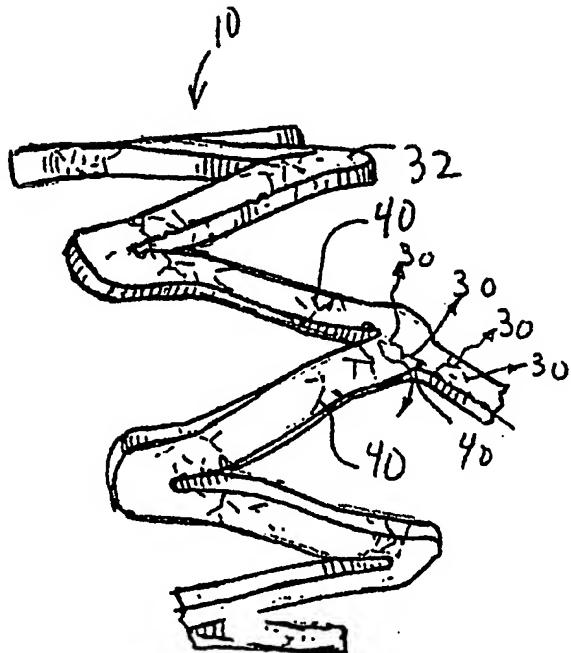
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(71) Applicant (for all designated States except US):	SCIMED LIFE SYSTEMS, INC. [US/US]; One SciMed Place, Maple Grove, MN 55311-1566 (US).	
(72) Inventors; and		Published
(75) Inventors/Applicants (for US only):	YANG, Dachuan [-/US]; 11274 49th Avenue North, Plymouth, MN 55442 (US). STANSLASKI, Joel [-/US]; 4016 Ensign Avenue North, New Hope, MN 55427 (US). WANG, Lixiao [-/US]; 12822 86th Place North, Maple Grove, MN 55369 (US).	With international search report.
(74) Agents:	CROMPTON, David, M. et al.; Crompton, Seager & Tuft, LLC, Suite 895, 331 Second Avenue South, Minneapolis, MN 55401-2246 (US).	

(54) Title: SURFACE PROTECTION METHOD FOR STENTS AND BALLOON CATHETERS FOR DRUG DELIVERY

(57) Abstract

A medical device, such as a stent or balloon of a balloon catheter which includes a body portion which has an exterior surface which contacts, at least in part, a vessel wall during treatment. The body portion is expandable from a first position, wherein the body portion is sized for insertion into the vessel lumen, to a second position, wherein at least a portion of the exterior surface is in contact with the lumen wall. The medical device includes a first coating disposed over at least a portion of the exterior surface of the body portion with the first coating including a drug or therapeutic substance which is intended for controlled release from the surface. The medical device further includes a second coating overlying at least a substantial portion of the first coating. The second coating includes a material that is generally impervious to elution of the drug or therapeutic substance therethrough when the body portion is in a first position when inserted into the vessel lumen. The material of the second coating is relatively inelastic so that the second coating fractures during expansion of the body portion to the second position to allow elution of therapeutic substance through a multiplicity of fissures formed through the second coating.



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Description

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SURFACE PROTECTION METHOD FOR STENTS AND BALLOON**CATHETERS FOR DRUG DELIVERY**Field of the Invention

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The present invention pertains to medical apparatus, particularly expandable stents, having a surface coating applied over a portion of the apparatus' surface. In particular, the present invention relates to a generally impermeable surface coating which protects therapeutic materials disposed under the surface coating from the surrounding environment until the release of these materials is desired and achieved through fracture of the surface coating.

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Background of the Invention

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While angioplasty has gained wide acceptance, abrupt closure and restenosis have been identified as possible subsequent occurrences. Abrupt closure refers to the acute occlusion of a vessel immediately after or within the initial hours following a dilation procedure. Abrupt closure can result in myocardial infarction if blood flow is not restored in a timely manner. The primary mechanisms of abrupt closures are arterial dissection and/or thrombosis. Restenosis refers to the re-narrowing of an artery after an initial successful angioplasty. Restenosis occurs primarily within the initial six months after angioplasty, and is believed due to the proliferation and migration of the cellular components of the arterial wall.

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Endovascular stents are placed in the dilated segment of a vessel lumen to mechanically block the effects of abrupt closure and restenosis. In U.S. Patent No. 5,514,154, Lau et al. disclose an expandable stent which is relatively flexible along its longitudinal axis. This flexibility facilitates delivery of the stent through tortuous body

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5 lumens. Additionally, the stent is stiff and stable enough radially, in an expanded
condition, to maintain the patency of a body lumen such as an artery when implanted
therein. Such stents have not, however, eliminated abrupt closure and have not eliminated
10 restenosis.

15 5 Recent developments have led to stents which attempt to provide anti-
thrombogenic and other medications to regions of a blood vessel which have been treated
by angioplasty or other interventional techniques. In U.S. Patent No. 5,464,650, Berg et
al. disclose a method for making an intravascular stent by applying to the stent, and in
20 particular to its tissue-contacting surface, a solution which includes a solvent, a polymer
dissolved in the solvent, and a therapeutic substance dispersed in the solvent. After the
solution is applied to the stent, the solvent is then evaporated leaving the
25 polymer/therapeutic agent surface treatment. Berg et al. assert that these devices are
capable of providing both short term medication delivery, over the initial hours and days
after the treatment, as well as long term medication delivery, over the weeks and months
30 30 after the treatment.

35 An ongoing problem with present drug release coatings applied to devices such as
stents is achieving a therapeutic concentration of a drug locally at a target site within the
body without producing unwanted systemic side effects. Implantation of vascular stents
40 is a prime example of a situation where local therapy is needed with drugs that also
produce unwanted systemic side effects. Because the stent is placed within a flowing
blood stream, during placement and upon implantation, potential unwanted systemic
45 effects may result from undesirable quantities of the therapeutic substance entering the
blood stream. Further, if quantities of therapeutic substance are released into the blood

5 stream during positioning of the stent, less is available for actual local treatment when the
stent is expanded, resulting in potential inadequate local dosing. The many attempts to
effectuate local drug delivery via endovascular means have failed to address controlling
10 of release of the therapeutic substance systemically during implantation and following
5 implantation.

15 Therefore, there exists a need in the art for a means and a method for providing
local therapy which can sustain high local concentrations of therapeutic drugs at a
predetermined site without producing unwanted side effects, such as unwanted quantities
20 of the drugs entering the blood stream. There especially exists a need to provide
adequate concentration of therapeutic agents directly to the boundary layer of blood flow
near the vessel wall at a targeted treatment area which greatly reduces the systemic side
25 effects and amount of drug needed to achieve a therapeutic result.

Summary of the Invention

30 The present invention provides a medical device, and a method for manufacturing
35 the medical device, which includes a thin layer overlying a releasable drug or therapeutic
40 substance layer. The thin overlying layer protects the drug layer during positioning and
45 deployment of the medical device within a body lumen. The thin overlying layer is
selected to be of a polymeric material and selected thickness which essentially prevents
elution of the therapeutic substance until the medical device is placed at a desired
location within the body lumen and expanded. The expansion of the medical device
produces fissures throughout the overlying layer through which the therapeutic substance
50 elutes. With this design, the therapeutic substance is assured to be applied at the local

5 selected delivery site with substantially reduced systemic effect from the drug entering
the blood stream and traveling away from the deployment site.

The present invention is useful in conjunction with local delivery of drugs or
therapeutic substances on an expandable stent within the vascular system. The invention
10 may also be utilized in conjunction with drug delivery from balloon catheters or stents for
use in other body lumens. The invention is particularly useful when utilizing a water
soluble drug or therapeutic substance which tends to dissolve and migrate within a blood
15 or other body fluid environment. It is also beneficial to use the overlying protective
coating when the drug is placed on the medical device with a hydrophilic polymeric
20 carrier, which is intended to dissolve and release the drug or therapeutic substance over
an extended period of time when the device is placed within the body lumen at a selected
site. The second or overlying layer of protective material, which fractures upon
25 expansion of the medical device, is preferably a biodegradable polymer which is
absorbed by the body over an extended period of time, but which prevents elution of the
30 drug or therapeutic substance during the time required to place the device within the
vessel lumen.

In preferred embodiments of the present invention, the medical device is one
35 which is designed for treating a vessel lumen wall, such as an arterial wall, in conjunction
with treating a stenosis at the same location. The medical device preferably includes a
40 body portion having an exterior surface defined thereon with the body portion being
expandable from a first position, wherin the body portion is sized for insertion into the
45 vessel lumen, to a second position, wherein at least a portion of the exterior surface of the
medical device is in contact with the lumen wall. A preferred medical device includes a

5 first coating disposed over at least a portion of the exterior surface of the body portion of
the medical device with the first coating including, at least in part, a drug or therapeutic
10 substance for treating the vessel wall. In preferred embodiments, the first coating
includes the drug or therapeutic substance in combination with a polymeric carrier which
5 preferably controls the rate of release of the drug or therapeutic substance over an
extended period of time. The therapeutic substance or drug releases from the first
15 coating, in preferred embodiments, in response to contact with fluid within the vessel
coating, in preferred embodiments, in response to contact with fluid within the vessel
lumen or at the vessel wall.

20 Preferred drugs or therapeutic substances which may be incorporated into the first
coating or included in the first coating with a polymeric carrier include heparin,
10 antibiotics, radiopaque agents, anti-thrombogenic agents, anti-proliferative agents, anti-
angiogenic agents, and combinations thereof. Specific drugs can include taxol, taxol
25 derivatives, colchicine, vinblastine or epothilones, which are classified as anti-
angiogenic agents, and combinations thereof. Specific drugs can include taxol, taxol
derivatives, colchicine, vinblastine or epothilones, which are classified as anti-
30 proliferative and anti-angiogenic agents. A preferred polymeric carrier for the drug or
therapeutic substance is a biodegradable agent which can include polylactic acid,
15 polyglycolic acid, polyethylene oxide, polycaprolactones, polydioxanone,
35 poly(orthoesters), polyanhydrides, polyphosphazenes, and mixtures or copolymers of
these polymeric materials. The polymeric material could also be selected to include non-
biodegradable polymers such as polyurethane, polysiloxane, polyacrylate and mixtures
40
45 and copolymers of these polymeric materials.

The present invention includes a second coating preferably overlying at least a
50 substantial portion of the first coating. The second coating includes at least in part a
material that is generally impervious to elution of the drug or therapeutic substance

5 therethrough when the body portion of the medical device is in the first position, while
being inserted and placed within the lumen. Further, the material of the second coating is
preferably relatively inelastic so that the second coating fractures during expansion of the
10 body portion of the medical device to the second position to allow elution of the drug or
therapeutic substance through fissures formed through the surface of the second coating.
15 The second coating of the present invention works particularly well in combination with
expandable stents or drug delivery balloons. The second coating is preferably a
polymeric material which can include polylactic acid, polyglycolic acid, polyanhydrides,
20 polyphosphazenes, poly(orthoesters) and mixtures and copolymers of these polymeric
materials. In preferred embodiments, the thickness of the second coating is about
10 0.01 μ m to about 5 μ m.
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A preferred medical device of the present invention includes a stent which is a
generally tubular structure having an exterior surface defined by a plurality of
30 interconnected struts having interstitial spaces therebetween. The generally tubular
structure is expandable from a first position, wherein the stent is sized for intravascular
insertion, to a second position, wherein at least a portion of the exterior surface of the
35 stent contacts the vessel wall. The expanding of the stent is accommodated by flexing
and bending of the interconnected struts throughout the generally tubular structure. The
second coating overlying the stent surface which protects the therapeutic substance or
40 drug during placement, fractures upon flexing and bending of the struts on the stent
during expansion.

45 The second coating of the present invention can also be utilized on a medical
device, such as a balloon catheter, wherein the second coating is included on at least a

5 portion of the balloon which is expandable from a folded or unexpanded first position to
an expanded second position which is adapted for treatment of the vascular lumen wall
by contact with at least a portion of the exterior surface of the balloon. The second
10 coating overlying the drug or therapeutic substance is again relatively inelastic so that
coating overlying the drug or therapeutic substance is again relatively inelastic so that
5 upon expansion of the balloon, the coating fractures to allow elution of the drug or
therapeutic substance through fissures formed in the coating.
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Additional features of the invention and the advantages derived therefrom, and the
various scopes and aspects of the invention will become apparent from the drawings, the
20 description of the preferred embodiments of the invention, and the claims.

10 Description of the Drawings

Fig. 1 is a perspective view of a stent in accordance with an exemplary
25 embodiment of the present invention;

Fig. 2 is a magnified, partial perspective view of FIG. 1 in a first, non-expanded
30 form, illustrating the polymeric surface coating selectively applied to wire members;

15 Fig. 3 is a magnified, partial perspective of FIG. 2 in a second, expanded form,
illustrating the polymeric fragmentation and subsequent elution of a therapeutic substance
35 arising from the expansion of the stent;

Fig. 4 is a schematic representation of a catheter of the present invention having a
40 folded balloon in a first position thereon inserted within a vessel lumen; and

20 Fig. 5 is a schematic representation of the catheter of Fig. 4 having the balloon in
a second expanded position for treatment of the vessel wall.

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Detailed Description of the Drawings

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Stents of the type shown in Fig. 1, disclosed in U.S. Patent Application Serial No. 08/874,190, filed June 13, 1997, entitled "Polymeric Layered Stents", perform the desired applications of dilating and maintaining the patency of various lumen passages within the human body. The above application is assigned to the assignee of the present invention, and the disclosure is hereby incorporated by reference.

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Referring now to the drawings wherein like reference numerals refer to like elements throughout the several views, Fig. 1 shows a perspective view of a stent 10, in a non-expanded form, in accordance with the present invention. The skeletal frame of the stent 10 preferably includes wire-like members 12 forming a distinct, repetitive serpentine pattern. This repetitive serpentine pattern consists of multiple U-shaped curves 14. These U-shaped curves 14 form interstitial spaces 16. With no recognizable beginning or end to this serpentine pattern, wire 12 forms expandable serpentine element 18. Serpentine elements 18 are arranged along the longitudinal axis of the stent 10 so that the U-shaped curves 14 of abutting serpentine elements 18 may be joined through an interconnecting element 20. Through the interconnecting elements 20, a continuous wire 12 framework is created between multiple serpentine elements 18 forming the stent 10.

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A surface treatment 30 is selectively applied to the skeletal frame of the stent 10. This surface treatment 30 comprises at least two overlying coatings selectively applied to at least a portion of the exterior surface of the wire-like members 12. The function of the two overlying coatings is best understood from the depictions in Fig. 2 and Fig. 3, as described below.

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5 Referring now to Fig. 2, a portion of the stent of Fig. 1 is depicted in magnified
view with the first coating 32 disposed over at least a portion of the exterior surface of
10 wire-like members 12. The first coating 32 includes at least in part, a therapeutic
substance or drug. In a preferred embodiment, the therapeutic substance is comprised, at
15 least in part, of an anti-proliferative or anti-angiogenic drug. This therapeutic substance
is typically dispersed and contained in a polymeric carrier matrix forming the first
coating 32. The use of a matrix allows for a selectively controlled elution rate for the
incorporated drug or therapeutic substance. By modifying the ratio of polymeric carrier
20 to therapeutic substance, the ability of the therapeutic substance to elute from the carrier
either increases or decreases. In a further preferred embodiment, the elution rate of the
therapeutic substance may be controlled by utilizing a biodegradable polymeric carrier.
25 Polylactic acid (PLA), polyglycolic acid, polyethylene oxide (PEO), polycaprolactone
are examples of such polymeric carriers. Either the homopolymer or the copolymer
forms of these materials may be utilized in the incorporation with the therapeutic
30 substance. Other polymeric carriers which may be utilized include: polyurethane,
15 polysiloxane, polyacrylate and their mixtures or copolymers.

35 Other therapeutic substances or drugs can also be incorporated into the first
coating, either alone or in combination with the anti-proliferative or anti-angiogenic
agents. These drugs can include heparin, antibiotics, radiopaque agents and anti-
40 thrombogenic agents.
20

45 These components may be added to the anti-proliferative or anti-angiogenic drug
in order to alter the function of the therapeutic substance. In a preferred embodiment, to
prevent the aggregation of platelets, fibrin, clotting factors, and cellular elements of the

5 blood as a result of the implementation of the stent 10, the anti-proliferative drug or anti-
10 angiogenic drug may also contain an additional anti-thrombogenic drug that may be
incorporated with the other drugs forming the first coating 32. In a further preferred
embodiment, the anti-angiogenic drug is Taxol, Taxol derivatives, colchicine, vinblastine,
15 5 or epothilone.

15 The second coating 34, preferably the outermost coating, overlays at least a
substantial portion of the first, or previous coating 32. This second coating 34 comprises
20 a material that is generally impervious to the elution of the therapeutic substance or drug
incorporated in the first coating 32. The second coating 34 acts as a protective coating
10 10 for the drug or therapeutic substance which prevents the drug or therapeutic substance
from elution prior to proper placement within the vessel lumen at a treatment site.
25 Further, this protective layer prevents physical damage to the drug coating layer during
insertion. In preferred embodiments, release of the therapeutic substance is enhanced by
30 contact with water or other liquids present in the blood or other body lumen. This is
15 15 particularly true in embodiments which incorporate a drug or therapeutic substance which
is water soluble or a polymeric carrier that is hydrophilic and tends to release more
35 therapeutic substance upon contact with a liquid such as water. Thus, the second coating
34 or overlayer of protective coating is preferably impervious to water or body fluids, at
40 least for the time period required for placement of the stent within the vessel lumen at the
20 20 treatment site. In this way, the elution of the drug is prevented until the medical device
or stent is located at the required treatment site.

45 Thus, in use, the stent or other medical device of the present invention is coated
with first a drug or therapeutic substance, followed by an overlying coat of a second

coating or protective coating. The first coating may be placed on the medical device while in an unexpanded configuration, or alternatively, the device may be expanded for coating and then contracted for placement in the vessel. The second coating, or protective coating, is made to overly the first coating while the medical device is in the first position for insertion in the lumen. In preferred embodiments, the second coating material is relatively inelastic so that the second coating fractures during expansion of the body portion of the medical device to the second position. The portion of the stent depicted in Fig. 2 is depicted in Fig. 3 in an expanded state, which clearly indicates a multiplicity of fractures or fissures 40 throughout the second coating 32 with the drug or therapeutic substance 30 eluting through the fissures 40.

As previously stated, the second coating is preferably a polymeric coating which
is relatively inelastic so that the expansion of the stent or other medical device causes
fractures to form within the coating surface. These fractures allow the elution of the drug
or therapeutic substance therethrough. A preferred polymeric material includes
15 polylactic acid, polyglycolic acid, polyanhydrides, polyphosphazene or poly(orthoester).
The thickness of the second coating is preferably about 0.01μm to about 5.0μm. The
second coating is preferably biodegradable or bioabsorbable so that over time the second
coating is absorbed by the body.

40 The present invention has been discussed in conjunction with a preferred stent.
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20 However, it is recognized that the invention disclosed herein may be utilized with any
42 stent design which is expanded from a first position to a second position with resultant
43 fracture of a second protective coating thereon. Preferred stents include those generally
44 tubular structures having an exterior surface defined by a plurality of interconnected

5 struts having interstitial spaces therebetween. In the first position, the stent is sized so
that it may be inserted into the lumen of the intravascular system. Once located at a point
of treatment, the stent may be expanded to a second position wherein at least a portion of
10 the exterior surface contacts the wall of the vessel lumen.

5 The use of a second protective coating, as described above for a stent, can also be
incorporated into a medical device such as a balloon-type drug delivery catheter or
15 balloon dilatation catheter. Figs. 4 and 5 depict the incorporation of the present invention
into a balloon catheter design. The materials and therapeutic substances discussed above
20 are equally applicable in the present balloon catheter embodiment.

10 Now referring to Fig. 4, a vessel 50 within the vascular system is depicted
schematically with a lumen 52 defined therethrough which is partially occluded by a
25 stenosis 54 therein. The lumen is defined by lumen walls 56 as indicated. A balloon
catheter 58 is depicted as being inserted into the vessel lumen 52. The balloon catheter
30 58 includes a shaft 60 having disposed on a distal portion thereof an inflatable balloon 62.
15 The balloon 62 is depicted in a folded or uninflated profile which is suitable for inserting
into the lumen 52 of the blood vessel 50.

35 The balloon 62 includes a drug or therapeutic substance coated on the surface
thereof. In preferred embodiments, the entire surface of the balloon is coated with a drug
40 or therapeutic substance, either alone or in a polymeric carrier, while the balloon is in an
inflated position so that the entire surface thereof includes the drug or therapeutic
45 substance thereon. The second coating or protective coating is applied while the balloon
is in a deflated or low profile condition. Again, this protective coating prevents the

5 elution of the drug from the surface of the balloon which is exposed during insertion of
the catheter prior to inflation of the balloon at the treatment site.

10 Referring now to Fig. 5, the balloon catheter 58 of Fig. 4 is depicted with the
balloon located across the stenotic area 54 in an inflated condition. As shown in Fig. 5,
5 the balloon includes a first coat 30, which includes the drug or therapeutic substance, and
a second coat, which is the protective coating which was applied when the balloon was in
15 a deflated condition. Fig. 5 schematically depicts the multiplicity of fissures 40 which
are formed in the balloon surface coating 32 upon expansion of the balloon. This results
20 in elution of the drug or therapeutic substance 30 through such fissures into the treatment
area.
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25 Numerous characteristics and advantages of the invention covered by this
document have been set forth in the foregoing description. It will be understood,
however, that this disclosure is, in many aspects, only illustrative. Changes may be made
30 in details, particularly in matters of shape, size, and arrangement of parts without
15 exceeding the scope of the invention. The invention scope is defined, of course, in the
language within the appended claims are expressed.
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Claims

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What is claimed is:

1. A medical device for treating a lumen wall comprising:

10 a body portion having an exterior surface defined thereon, said body portion being expandable from a first position, wherein said body portion is sized for insertion into said lumen, to a second position wherein at least a portion of said exterior surface is in contact with said lumen wall;

15 a first coating disposed over at least a portion of said exterior surface of said body portion, said first coating comprising at least in part a therapeutic substance; and,

20 a second coating overlying at least a substantial portion of said first coating, said second coating comprising a material that is generally impervious to elution of said therapeutic substance therethrough when said body portion is in said first position when inserted in said lumen, while being relatively inelastic so that said second coating fractures during expansion of said body portion to said second position to allow elution of said therapeutic substance through fissures formed therethrough.

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2. The medical device of claim 1, wherein said device is an expandable stent.

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3. The medical device of claim 1, wherein said device is a balloon catheter.

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4. The medical device of claim 1, wherein said therapeutic substance releases from said exterior surface in response to fluid contact absent said second coating.

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5 5. The medical device of claim 1, wherein said therapeutic substance is selected from the group consisting of: heparin, antibiotics, radiopaque agents, anti-thrombogenic agents, anti-proliferative agents, anti-angiogenic agents and combinations thereof.

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15 6. The medical device of claim 5, wherein said anti-proliferative and anti-angiogenic agents are selected from the group consisting of: taxol, taxol derivatives, colchicine, vinblastine or epothilone.

20 7. The medical device of claim 4, wherein said fluid contact includes blood within said lumen.

25 8. The medical device of claim 1, wherein said first coating further comprises a polymeric carrier having said therapeutic substance dispersed therethrough.

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9. The medical device of claim 8, wherein said polymeric carrier is biodegradable.

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40 10. The medical device of claim 9, wherein said polymeric carrier is selected from the group consisting of: polylactic acid, polyglycolic acid, polyethylene oxide, polycaprolactone, polydioxanones, polyanhydrides, polyphosphazenes, poly(orthoesters) and mixtures or copolymers thereof.

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5 11. The medical device of claim 1, wherein said second coating is a polymeric
material selected from the group consisting of: polylactic acid, polyglycolic acid,
polyanhydrides, polyphosphazenes, poly(orthoesters) and mixture and copolymers
10 thereof.

15 12. The medical device of claim 11, wherein said second coating of a thickness
of about 0.01 μ m to about 5.0 μ m.

20 13. An intravascular stent adapted for treating a vessel wall comprising:
a generally tubular structure having an exterior surface defined by a plurality of
25 interconnected struts having interstitial spaces therebetween, said generally tubular
structure expandable from a first position, wherein said stent is sized for intravascular
insertion, to a second position, wherein at least a portion of said exterior surface contacts
30 said vessel wall, said expanding of said generally tubular structure accommodated by
flexing and bending of said interconnected struts;

35 a first coating disposed over at least a portion of said exterior surface of said
generally tubular structure, said first coating comprising at least in part a therapeutic
substance; and,

40 a second coating overlying at least a substantial portion of said first coating, said
second coating comprising a material that is generally impervious to elution of said
therapeutic substance therethrough when said body portion is in said first position within
45 said intravascular lumen, while being relatively inelastic so that said second coating
fractures in response to flexing and bending of said struts during expansion to said second

5 position to allow elution of said therapeutic substance through fissures formed therethrough.

10 14. The stent of claim 13, wherein said therapeutic substance releases from said exterior surface in response to fluid contact absent said second coating.

15 15. The stent of claim 13, wherein said therapeutic substance is selected from the group consisting of : heparin, antibiotics, radiopaque agents, anti-thrombogenic agents, 20 anti-proliferative agents, anti-angiogenic agents and combinations thereof.

25 16. The stent of claim 15, wherein said anti-proliferative and anti-angiogenic agents are selected from the group consisting of: taxol, taxol derivatives, colchicine, vinblastine and epothilone.

30 17. The stent 14, wherein said fluid contact includes blood within said lumen.

35 18. The stent of claim 13, wherein said first coating further comprises a polymeric carrier having said therapeutic substance dispersed therethrough.

40 19. The stent of claim 18, wherein said polymeric carrier is biodegradable.

45 20. The stent of claim 19, wherein said polymeric carrier is selected from the group consisting of: polylactic acid, polyglycolic acid, polyethylene oxide,

5 polycaprolactone, polydioxanone, polyanhydrides, polyphosphoanes, poly(orthoesters) and mixtures or copolymers thereof.

10 21. The stent of claim 13, wherein said therapeutic substance is elutable in contact with water containing fluids absent said second coating.

15 22. In an intravascular medical device having a body portion with an exterior surface defined thereon, at least a portion of said body portion which is expandable from
20 a folded or unexpanded first position, which is adapted for insertion into a vascular lumen to an expanded second position, which is adapted for treatment of the vascular lumen wall by contact with at least a portion of said exterior surface, the improvement
25 comprising:

30 a first coating disposed over at least a portion of said exterior surface of said body portion, said first coating comprising at least in part a therapeutic substance; and,

35 a second coating overlying at least a substantial portion of said first coating, said second coating comprising a material that is relatively inelastic so that said second coating fractures during expansion of said body portion to said second position to allow elution of said therapeutic substance through fissures formed therethrough.

40 23. The intravascular medical device of claim 22, wherein said therapeutic substance releases from said exterior surface in response to fluid contact absent said
45 second coating.

5 24. The intravascular medical device of claim 22, wherein said therapeutic
 substance is selected from the group consisting of : heparin, antibiotics, radiopaque
 agents, anti-thrombogenic agents, anti-proliferative agents, anti-angiogenic agents and
10 combinations thereof.

15 25. The intravascular medical device of claim 24, wherein said anti-proliferative
 and anti-angiogenic agents are selected from the group consisting of: taxol, taxol
 derivatives, colchicine, vinblastine and epothilones.

20 26. The intravascular medical device of claim 22, wherein said first coating
 further comprises a polymeric carrier having said therapeutic substance dispersed
25 therethrough.

30 27. The intravascular medical device of claim 26, wherein said polymeric carrier
 is biodegradable.

35 28. The intravascular medical device of claim 27, wherein said polymeric carrier
 is selected from the group consisting of: polylactic acid, polyglycolic acid, polyethylene
 oxide, polycaprolactone, polydioxanone, polyanhydrides, polyphosphazenes,
40 poly(orthoesters) and mixtures or copolymers thereof.

45 29. The intravascular medical device of claim 22, wherein said therapeutic
 substance is elutable in contact with water containing fluids absent said second coating.

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30. A catheter for drug delivery comprising:

a longitudinally extending shaft having a distal end and a proximal end, the shaft

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defining an inflation lumen;

15 a balloon member having an exterior surface defined thereon disposed proximate the distal end of said shaft in fluid communication with said inflation lumen, said balloon member expandable from a first deflated position, wherein said balloon member is sized for intravascular insertion, to a second inflated position, wherein at least a portion of said exterior surface contacts said vessel wall;

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25 a first coating disposed over at least a portion of said exterior surface of said balloon member, said first coating comprising at least in part a therapeutic substance; and,

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35 a second coating overlying at least a substantial portion of said first coating, when said balloon member is in said first deflated position, said second coating comprising a material which is relatively inelastic so that said second coating fractures in response to expansion of said balloon member to said second position to allow elution of said therapeutic substance through fissures formed therethrough.

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31. The catheter of claim 30, wherein said therapeutic substance releases from said exterior surface in response to fluid contact absent said second coating.

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32. The catheter of claim 30, wherein said second coating is a polymeric material selected from the group consisting of polylactic acid, polyglycolic acid,

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5 polyanhydrides, polyphosphazenes, poly(orthoesters) and mixtures and copolymers thereof.

10 33. The catheter of claim 30, wherein said therapeutic substance is selected from the group consisting of: taxol, taxol derivatives, colchicine, vinblastine and epothilone.

15 34. The catheter of claim 30, wherein said therapeutic substance is elutable in contact with water containing fluids absent said second coating.

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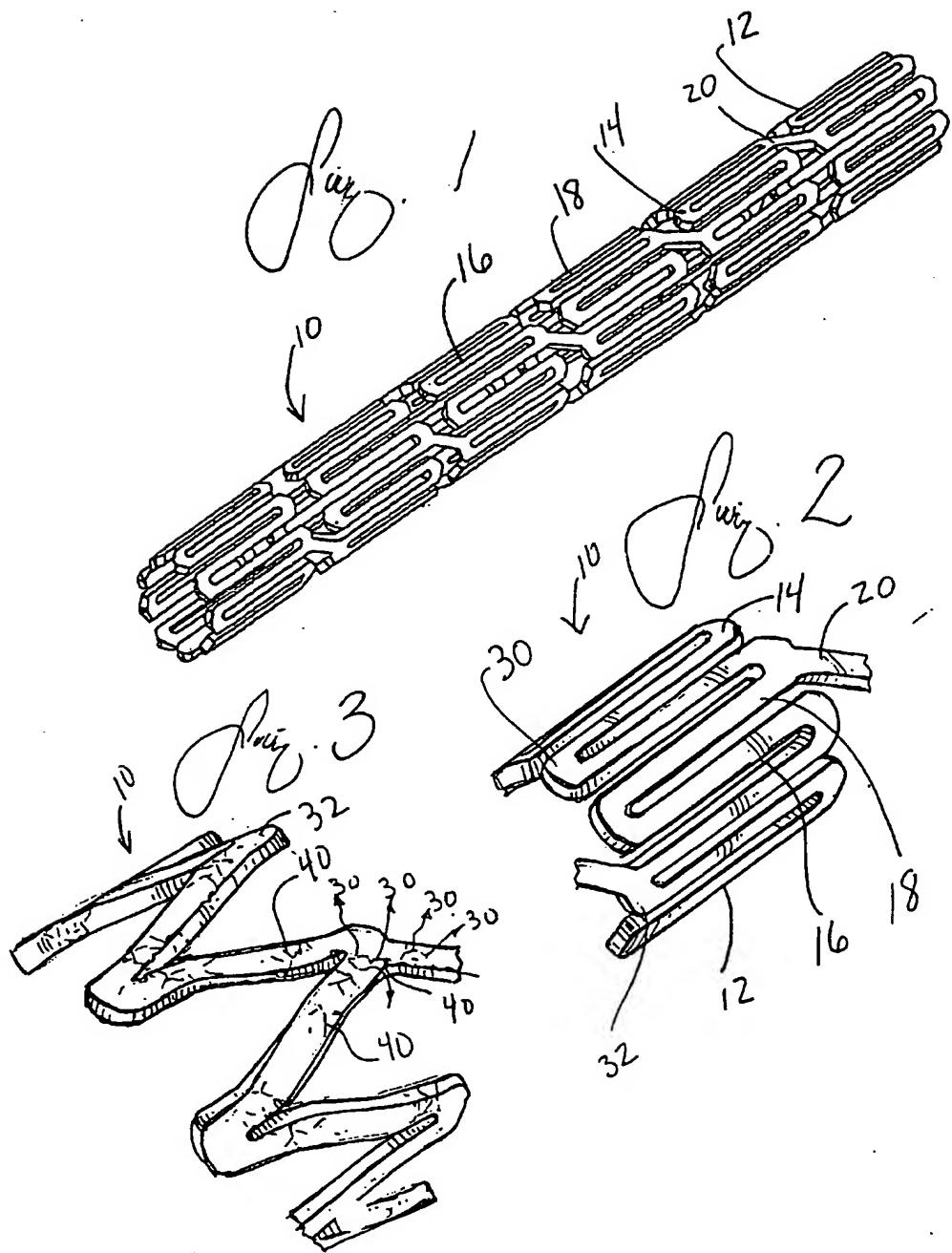
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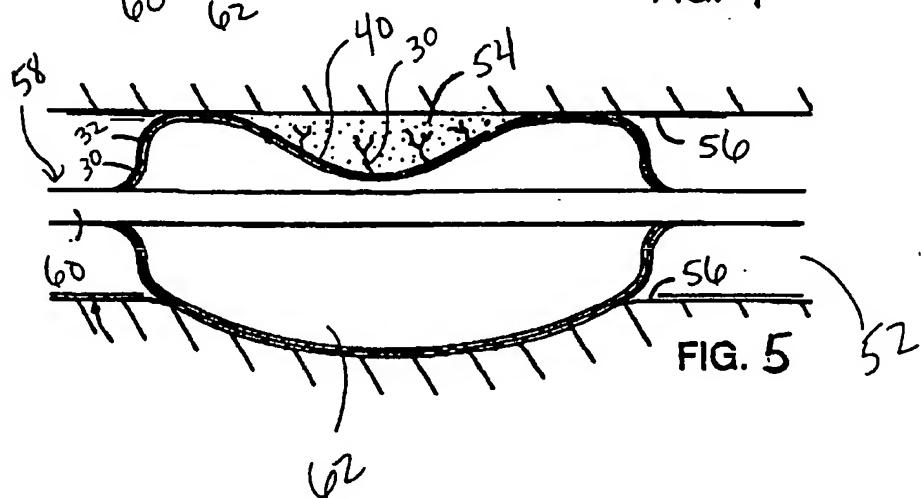
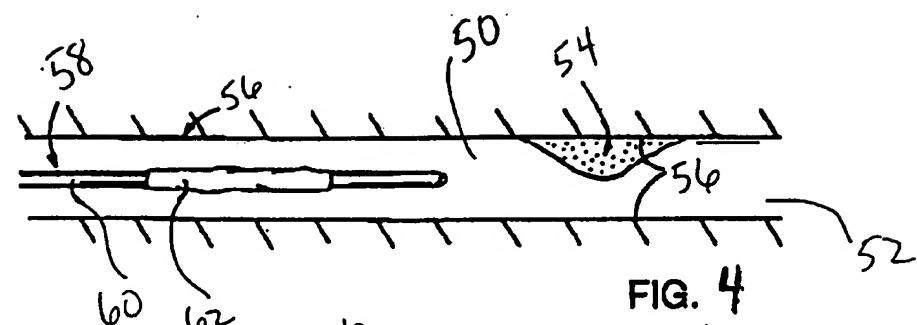
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